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Super-FRS slit system and possible passive cooling techniques

J. Gellanki[1], *C. Douma*[1], *N. Kalantar-Nayestanaki*[1], *O. J. Kuiken*[1], *M. F. Lindemulder*[1], *H. Moeini*[1], *C. Nociforo*[2], *C. Rigollet*[1], *H. A. J. Smit*[1], *H.J. Timersma*[1], *K. H. Behr*[2], *C. Karagiannis*[2], *M. Gleim*[2], *C. Schlör*[2], *H. Simon*[2], and *M. Winkler*[2]

[1a]KVI-CART, University of Groningen, NL-9747 AA, Groningen, The Netherlands; [2b]GSI, D-64291 Darmstadt, Germany

X− and Y− position slit systems will be used to stop the unwanted charge states of the primary beam and fragments produced at the reaction target of the Super-FRS at the FAIR facility, GSI. In the case of the most frequently used fission reaction of ^{238}U beam at 1.5 GeV/u on ^{12}C target (2.5 g/cm^2), one of the lowest charge states of ^{238}U fragments produced at the target may reach one of the X-slits with an energy of about 1.3 GeV/u with a maximum power of 500 W. The basis of the Super-FRS X− and Y− slit systems are two DENSIMET®185 (97% Tungsten, 2% Nickel and 1% Iron) metal blocks, which have to move in a vacuum chamber in horizontal direction $(0 - 400\ \mathrm{mm})$ and in vertical direction $(0 - 200\ \mathrm{mm})$, respectively. Due to the highly radioactive environment,

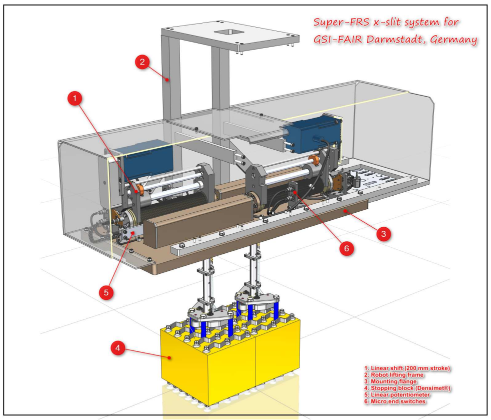

Figure 1: Schematics of the Super-FRS slit system which is under construction at KVI-CART, is shown.

some of the slits are designed to allow for robot handling. Overview of Super-FRS slit system is shown in the Fig. 1. NX advanced thermal simulations Ref. [1] are carried out to estimate the maximum and minimum temperature values on the slits and on the apparatus in the neighborhood of the slits. Several cooling methods have been simulated on a block of DENSIMET with a proposed dimensions of $200 \times 180 \times 250\ \mathrm{mm}^3$, and which will be used in the pre-separator of the Super-FRS beam line. The present results from the thermal simulations suggest two new possible passive cooling techniques to lower the temperature of the block by substantial amounts without any water cooling during experiments.

Simulations and the new passive cooling techniques have been tested by a test run at the AGOR beam line at KVI-CART. In this run, three different densimet blocks: 1) pure densimet (emissivity $\sim$ 0.07; as per literature), 2) densimet block with welded stainless steel (SS) strips as radiators (SS emissivity $\sim$ 0.65) and 3) densimet block with cerablack coating Ref. [2] of thickness 0.15 mm (cerablack emissivity $\sim$ 0.9) have been used. The pure block and the block with SS strips having the same dimensions of $30 \times 30 \times 50\ \mathrm{mm}^3$ and the coated block is of $25 \times 25 \times 50\ \mathrm{mm}^3$. Each block has been exposed with ^{20}Ne beam of power Q = 21 W for about four hours. Preliminary results of this test run are shown in the Fig. 2. As seen from the figure, the densimet block with the cerablack coating radiates out the heat much faster than the other two blocks. Further details can be found in Ref. [3].

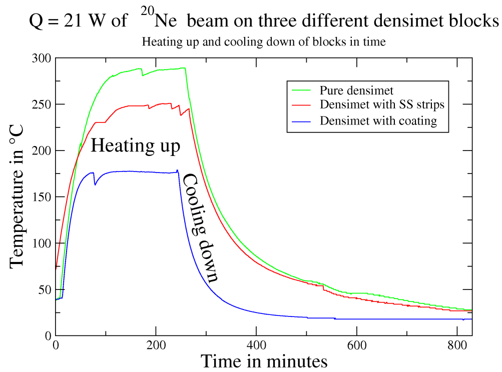

Figure 2: Preliminary results of test run with ^{20}Ne beam are shown. Heating and cooling responses of the pure densimet block are shown in green. The same is shown for the block with stainless steel welded strips and cerablack coating by the red and the blue solid lines, respectively. As seen in the picture, each densimet block was exposed to a beam (heating up) for about four hours. The decrease in temperature of each curve represents the cooling down of the corresponding block. For more details see text.

References

[1] Siemens NX (NX Thermal and Flow) software.

[2] http://atfinet.com/index.php/applications/thermal-management/high-emissivity-coatings.

[3] J. Gellanki et al., *To be submitted to Nucl. Instr. Meth. Phys. Res. A.*

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